REMARKS

Examiner and applicant had a telephone conference (description attached herewith) on claim formation, specifically claim 1 and new claim 21 (related to Claim 1) and based on the specification and not covering the Prior Art (Tsuji: US 6,350,998). Based on the teleconference, EXAMINER and applicant reached to the agreement on the claim 1, as amended and as shown in **Page 2**, and also including of a new claim as Claim 21, as shown in **Page 8**.

Reconsideration of this application as amended is respectfully requested. Claims 1-2, 5, 14, 17, and 20 have been amended. Claims 3-4, 6-10, and 12, which were previously withdrawn, have also been amended. The Claim 21 has been included as the new claim. Claims 11, 15-16, and 18-19 are previously withdrawn. The amended and included claims are fully supported by the specification or drawings. I remarks below are directed to the claims as amended herein.

Election/ Restrictions

Claims 1-2, 5, 14, 17, and 20 are corrected as objected by Examiner, Dr. WAI-SING LOUIE. Claims 3-4, 6-13, and 12, previously withdrawn, have also been corrected currently. Claims 13, 15-16, and 18-19 were previously withdrawn. I respectfully retain the right to file Divisional patent applications for the remaining embodiments during pendency of this application.

Claim Objections

As objected by Examiner, I corrected the claims 1-2, 5, 14, 17, and 20. Amended Claim 1 and included new claim 21 are based on the agreement that reached between the EXAMINER and applicant through Tele-conference on March 3 and March 6.

Claim Rejections-35 U.S.C.§ 102(b)

Claim 1 is rejected under 35 U.S.C.§ 102(b) as being anticipated by U.S. Patent US 6,350,998 of Tsuji ("Tsuji"). I, respectfully submit the claim 1 which is not anticipated by Tsuji.

Claim 1 recites:

A photodiode comprising,

first ohmic contact layer;

a semiconductor structure comprising of;

a semiconductor substrate;
a highly doped buffer layer, material-type same as the substrate;
a single or multiple layers of InGaAs with different compositions of In, Ga, and As without containing of Al for absorption layer;
a doped-thin layer of InGaAs, and;
a highly doped-thick layer of InGaAs for second ohmic contact, wherein a window is created for incident light to reach the thin layers and wherein window is in u-shape or horse-shoe shape, and;

a second ohmic metal contact on the top of the doped-thick layer.

Tsuji discloses photodiode, type of which is avalanche multiplication type semiconductor photodetector: APD (Tsuji, Lines 51 to 55 of Col. 2) having the semiconductor structure with the multiplication layer provided on semiconductor substrate and multiplication layer of InAlGaAs (Tsuji: Lines 59 to 61 and Lines 66 to 67 of Col. 2; Col, 7, Lines 13-14 and Fig. 5; Col.7, Lines 54-55 and Fig. 6; Col. 8, Lines 37-38 and Fig.7), the composition thereof being graded (Tsuji: Lines 1 to 2 of Col. 3; Col. 7,

Line 15 and Fig.5; Col.7, Line 56-58 and Fig. 6; Col.8, Lines 39-40 and Fig. 7) to permit the electric field relaxation.

Tsuji discloses the multiplication layer of 3 (Tsuji: Figs, 5 to 7) which is mainly based on InAlGaAs (Tsuji: Col, 7, Lines 13-14 and Fig. 5; Col.7, Lines 54-55 and Fig. 6; Col. 8, Lines 37-38 and Fig.7) and graded layer 4 (Tsuji: Fig. 5) for field relaxation purpose is based on InAlAs (Tsuji: Col, 7, Lines 20-21 and Fig. 5) or InAlGaAs with its compositions are being graded (Col.7, Lines 56-58 and Fig. 6; Col. 8, Lines 37-38 and Fig.7). The multiplication layer 3 and graded layer 4 of Tsuji's disclosed photodiode are on the absorption layer (Tsuji: Col.7, Lines 57-58 and Fig. 6; Col. 8, Lines 40-41 and Fig.7). The multiplication layer 3 and the graded layer 4, that Tsuji disclosed, does not contain InGaAs layer without containing Al in it, as claimed in my Claim 1.

Tsuji discloses the APD in where highly doped cap layer 6 of InP (Tsuji: Col7, Lines 17-18 and Fig. 5; Col.7, Lines 60-62 and Fig. 6; Col. 8, Lines 42-44 and Fig. 7) is used before utilizing the doped InGaAs. Tsuji discloses the contact formation layer (on which the metal contact locates) comprising with highly doped InP 6 and InGaAs layers 7. Tsuji does not use high doped InGaAs layer without using InP cap layer, as cited in my Claim 1.

The photodiode that Tsuji discloses is the APD type photodiode in where multiplication layer 3 and electric filed relaxation layer 4 are included in the photodiode structure. Thus, Tsuji, does not disclose or suggest about the photodiode structure (not APD), as cited by my claim 1. In addition Tsuji discloses the photodiode structure in where contact formation layer comprising with the highly doped InP and highly doped InGaAs layer, different from contact layer formation layer, as cited by my claim 1. Furthermore, Tsuji's photodiode structure is targeted for optical communication application where 1310 and 1550 nm are usually used, and high structured can not be used for the shorter wavelength as Tsuji discloses InP usage as the cap layer 4. In addition, Tsuji opening window is not circular or U-shape, as claim in my claim 1. The structure as cited in claim 1 can be used for broad spectrum absorption.

In view of the clear distinctions, mentioned above, I submit the Claim 1 is not anticipated or rendered obvious by Tsuji.

Claim Rejections-35 U.S.C.§ 103(a)

Claims 2, 5, 14, 17, and 20 are rejected under 35 U.S.C.§ 103(a) as being unpatentable over U.S. Patent US 6,350,998 of Tsuji ("Tsuji") in view of U.S. Patents: US 6,949,770 of Yamaguchi et. al. ("Yamaguchi"), US 5,302,449 of Eby et. al. ("Eby"), and US 6,765,276 of Fasen et. al. ("Fasen").

Based on the clear distinctions, mentioned above, as Claim 1 is not anticipated or rendered obvious by Tsuji, Claims 2, 5, 14, 17, and 20 are patentable and are not in view of Yamaguchi, Eby, and Fasen. I, respectfully submit the claim 2, 5, 14, 17, and 20 and explain in view of Yamaguchi, Eby, and Fasen.

Claim 2 recites,

> The photodiode array comprises:
>
> NxN photodiodes, wherein each photodiode comprises,
>
> common ohmic metal contact layer on the backside of the semiconductor substrate for all photodiodes in the array;
> the said semiconductor structure as claimed in claim 1, and;
> the said second ohmic-contact layer on the top of the highly doped-thick InGaAs layer as claimed in claim 1, and;
>
> monolithically fabricated interconnection metal line, wherein each metal line is connecting each photodiode to the outside pad, and each photodiode is independently addressable, and;

an antireflection coating (AR) layer,

wherein surrounding region of each photodiode in the said array is etch out at least to a portion of the said absorption layer and wherein the light is incident from the top of the photodiode.

Yamaguchi discloses photodiode array, which is formed on the semi-insulating InP substrate 10 (Yamaguchi, Col. 3, Lines 61-62 and Fig. 3) on which, layers of n-type InP, absorbtion layer, and p-type InGaAs and InP layers are formed to make photodiode (Yamaguchi, Col. 3, Lines 64-67 and Fig. 3; Col. 4, Lines 1-2 and Fig. 3). Yamaguchi discloses photodiode, fabricated onto the semi insulating substrate 10. For each photodiode, p-type electrode 16 and n-type electrode 15. Their n-type electrode 15 are not common and are separated through making the trench 17. Yamaguchi does not suggest or discloses the structure of the photodiode array fabricated on the semiconductor substrate whose one of the electrode is common ohmic metal contact for the array and surrounding region of each diode is etch-out , as cited in my claim 2 (in accordance with claim 1 cited), and thereby the claim 2 (in accordance with the Claim 1 cited) is not anticipated or rendered obvious by Yamaguchi.

Yamaguchi discloses the photodiode array, in where metal contact layer 23 is onto the antireflective coating 22 (Yamaguchi, Col. 4, Lines 52-54 and Fig. 3), but not on the top ohmic contact of the photodetector array, as cited in my Claim 2. Thus, the claim 2 cited is not anticipated by yamaguchi.

Furthermore, semiconductor structure, as cited in my claim 2 which dependent on Claim 1, does not anticipated or rendered by Tsuji, as mentioned above (in accordance to Claim 1).

Yamaguchi discloses one-dimensional back-illuminated photodiode array, wherein interconnection metal line is the wire and is connecting to the top metal contact to outside pad 50 (Yamaguchi, Fig. 7a). The interconnection metal lines of two-dimensional (NXN), as cited in my claim 2, are the monolithically fabricated metal lines

and connected each photodiode to outside pad, and the metal line is located on the top side where light is also illuminated. Thus, the interconnection metal lines, as cited in Claim 2, is not anticipated or rendered by Yamaguchi.

Due to above mentioned reasons and also because Claim 2 depends from and further limit claim 1, I submit Claim 2 also is not anticipated or rendered obvious by Yamaguchi.

Claim 5 cites,

> The photodiode array comprises:
>
> NxN photodiodes, wherein each photodiode comprises,
>
> antireflective coating (AR);
> a common ohmic contact layer;
> a etch-off semiconductor substrate to open for incident light;
> the said semiconductor structure as claimed in claim 1; and;
> the said second ohmic metal contact layer, as claimed in Claim 1,
> on the top of the said highly doped-thick InGaAs layer;
>
> wherein a common ohmic contact connecting directly to the substrate, can be made by opening thru-hole from front side of the substrate to make compatible for flip-chip bonding .

Yamaguchi discloses the photodiode array in where trench is made to isolate each photodiode from one another (Yamaguchi, Col. 5, Lines 12-13 and Fig. 5a). Yamaguchi does not disclose or suggest the etch-off substrate to open for the incident light, as cited in my claim 5. Flip-chip bonded, as mentioned in original Claim 5 has been taken out and is currently amended. Yamaguchi discloses the photodiode array which is mostly one dimensional (Yamaguchi, Figs. 1a, 5a, 6a, and 7a) and Yamaguchi does not suggest and discloses of two dimensional array (NxN), as cited in my Claim 5.

In view of the clear distinctions, mentioned above, and also because Claim 5 depends from and further limit claim 1, I submit the Claim 5 is not anticipated or rendered obvious by Tsuji and not modified by Yamaguchi.

Claim 14 cites,

> The AR coating as claimed in claim 2 is single layer or multiple layers of metal oxides.

Eby discloses metal oxide based AR coating layer 70 for the substrate coating to reduce the visible reflectance (Eby, Col. 1, Lines 36-49 and Fig. 1) and to protect from environment (Eby, Col. 1, Lines 48-57) and abrasion (Eby, Col. 7, Lines 8-10). Eby discloses about the AR coating for the transparent substrate like glass for window applications (Eby, Col.1, Lines 6-8 and Lines 16-18). However, Eby does not discloses or suggests about the coating for any optical photodiode application as cited in my claim 14 (dependent to Claim 2). In addition, Yamaguchi discloses the AR coating layer 22 based on SiO_xN_y (Yamaguchi, Col.4, Lines 51-52). However, Yamaguchi does not suggest or discloses about the use of metal oxide for AR coating, as cited in my claim 14. Thus, in view of the clear distinctions, as mentioned above, and also because Claim 14 depends from and further limit claim 1, I submit, the claim 14 is not anticipated or rendered obvious by Tsuji and not modified by Eby and Yamaguchi.

Claim 17 cites,

> At least one tunable filter can be monolithically integrated on the said photodiode, as claimed in Claim 1, to tune the wavelength as necessary.

Claim 20 cites,

> At least one tunable filter can be integrated with the photodiode array, as claimed in claim 2 to filter the wavelengths spatially along the

arrays.

Fasen discloses the color filter which is fixed, but not the tunable filter, and mainly based on the RGB filter for visible light filtering (Fasen, Col. 4, Lines 60-63 and Col. 5, Lines 56-60) for the CMOS based image sensing device (Fasen, Col. 3, Lines 45-47). The RGB filter that Fasen discloses, having filtering wavelength broad and that is for the CMOS sensor. Fasen neither disclose or suggests about the tunable filter for the photodiode, nor mention the way to tune the wavelength, as cited in my Claims 17 and 20. Thus, based on the clear distinctions, mentioned above, and also because Claims 17 and 20 depend from and further limit claim 1, I submit, claims 17 and 20 are not anticipated or rendered obvious by Tsuji and not modified by Fasen and Yamaguchi.

I submit that, at least for the reasons given above in reference to Claim 1-2, Tsuji Yamaguchi, and Fasen do not disclose or suggest the above-recited limitation, and therefore that Claims 2, 5, 14, 17, and 20 are not anticipated or rendered obvious by Tsuji, and Yamaguchi, and Fasen. Claims 3-4, 6-10, and 12, which were previously withdrawn, have also been amended and those are dependent on the Claim 1. The Claim 21 has been included as the new claim and similar to claim 1. Only difference is that the opening window is in circular-shape, square-shape, or rectangular in shape (this Patent Application, Page 2: Para. 0014; Para-0015; Para-0019; Page 4: Para-0048; Para-0051). Claims 11, 15-16, and 18-19 are previously withdrawn.

Conclusion

I, Achyut Dutta, respectfully submit that claims 1-2, 5, 14, 17, and 20 for amendment and claims 3-4, 6-10, and 12, previously withdrawn and currently included are in condition for allowance. The claims 1 amendment (as amended and shown here) and including of claim 21 are agreed by Examiner through tele-conference on March 3 and 6, 2006. Others dependent claims are also briefly discussed and agreed, if Claim 1 is amended, as EXAMINER suggested. I (the undersigned inventor) would be obliged to have a telephone interview with the examiner, if necessary, to finalize the dependent claims.

Respectfully submitted,

3/15/06.
Date

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Enclosures:

(a) This Amendment (based on Interview)-Pages 17
(b) Description of the Telephone communication (Page 5)
(c) Certificate of Express Mailing (Page 1)
(d) Acknowledgement postcard (1)